Status of CRESST and Cryogenic Future of Direct WIMP Search

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Overview

• CRESST
  – Technique
  – Quenching factors
  – Status: Results & Upgrade

• Future
  – SuperCDMS
  – EURECA
CRESST

Cryogenic Rare Event Search with Superconducting Thermometers

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Technische Universität München
University of Oxford
Universität Tübingen
Laboratori Nazionali del Gran Sasso
CRESST – Technique

- WIMP Target: scintillating CaWO$_4$ single crystals
- Cryogenic detectors, thermal readout: TES
- Simultaneous measurement of thermal signal and scintillation light for background discrimination
- Light detection with separate cryogenic detector; reflective housing for efficient light collection

Electron recoils from $\beta$s and $\gamma$s

Nuclear recoils from neutrons
CRESST – Technique
CRESST – Quenching

- Different light yield for electron and nuclear recoils (Quenching)
- Three types of nuclei (O, Ca, W), need detailed investigation (WIMPs: mainly W-recoils !!)
- Three different approaches:
  - Standard neutron source
  - Neutron scattering experiment
  - Ion irradiation
  All three show less light for heavier nuclei!
CRESST – Status: Results

- Spring 2004: ~ 2 months run, total exposure ~ 20 kg d
- 2 detectors (one with very good light resolution)
- No neutron shield, no muon veto

⇒ Analysis threshold: 12 keV, WIMPs: < 40 keV recoil (W)
⇒ Nuclear recoils: 16 events or (0.9 ± 0.2)/ kg d
⇒ Good resolution in Daisy/BE 13: 0 evts with high QF
CRESST – Status: Results

Result robust w.r.t. changes of analysis threshold and QF!
CRESST – Status: Upgrade

Upgrading since April 2004
• Neutron moderator, 11 t PE installation ready
• Muon veto installed
• 66 channel SQUID system for 33 detector modules (10 kg) installed
• Detector integration system being produced
• Some more work on electronics, DAQ (testing, integration)
Future

- **SUSY prediction:** $\sigma > 10^{-12}$ pb
- **Present status:** $2 \times 10^{-7}$ pb
- **Cryos:** presently upgrading to sensitivity $\sim 10^{-8}$ pb
- **Proposals for next generation experiments (\sim 1$ ton target):**
  - liq. Xe: ZEPLIN (UK), XENON (US)
  - cryo: SuperCDMS (US) EURECA (EU)
- **no signal / $\sigma < 10^{-11}$ pb:** SUSY (almost) excluded ???
- **$\sigma \sim 10^{-7}$ pb:** astro/particle physics with next gen. exp.
Future – SuperCDMS

• Long term goal: $10^{-11}$ pb
• Target: up to $\sim 1$ ton Ge
• Strategy: several phases
  - Continue at Soudan, develop/test/run new detectors
  - **Move to SNOLab, 27 kg (A)**
  - **Increase mass: 145 kg (B)**
  - **Final phase: 1100 kg (C)**
• Zero BG:
  - Improve detector discr.
  - Reduce contamination
  - Improve analysis
Future – EURECA

CRESST & EDELWEISS + new groups:
University of Oxford
MPI für Physik, Munich
Technische Universität München
Universität Tübingen
Universität Karlsruhe
Forschungszentrum Karlsruhe
CEA/DAPNIA Saclay
CEA/DRECAM Saclay
CNRS/CRTBT Grenoble
CNRS/CSNSM Orsay
CNRS/IPNL Lyon
CNRS/IAP Paris
CERN

- Goal $10^{-10} - 10^{-11}$ pb
- Target: several 100 kg, different materials (A-dependence of spectrum / spin dependence)
- CRESST & EDELWEISS as R&D

European Underground Rare Event Calorimeter Array
Future – EURECA

Tasks:
• Detector development (discrimination, module size, new materials, mass production)
• Low radioactivity (material selection, processing, handling)
• Neutron background (μ-veto, shielding, MC simulations)
• Cryogenics (cold volume, cooling power, radiopurity, duty cycle)
• Electronics, readout, cabling
• Underground site issues (shielding, rock activity, space, infrastructure, safety)
Future – EURECA

ILIAS:
Integrated Large Infrastructure for Astroparticle Science
(EU Integrated Infrastructure Initiative)

- Provides platform for general discussion
- Covers some tasks partly in different substructures:
  - Neutron background MC simulations (e.g. N3, BSNS)
  - Low radioactivity (JRA1)
  - Underground site issues (N2)
Future – EURECA

First steps:
• Run next phase of EDELWEISS and CRESST
• Demonstrate technology on several kg scale
• Start R&D (cryogenics, detectors, electronics, simulations)
• Find WIMPs